and copper cable) are increasing. Below is a chart of the amount of the various outside plant investments produced by the SM

Outside Plant Investments produced by HCPM

	Amount	
Copper	$1,200,677,417	67%
Fiber	288,007,775	16%
Conduit	156,413,746	9%
Poles	149,067,465	8%
Total	$1,794,166,403	

Fiber cable is only a small portion (16%) of the outside plant investment produced by the model. If the cost of 16% of the plant is decreasing over time while the other 82% of the plant cost is increasing dramatically over time one would expect that the current cost of building the facilities would be greater than what those facilities cost to build in the past. This is not the results that are produced by the SM. The SM estimates that the cost of building outside plant facilities is declining.

The FCC used the above TPI information in calculating its expense factors. The use of this information produces a current cost for outside facilities that is significantly higher than the actual historic cost of the plant as reflected on the ILEC's books. As stated previously, the use inflated current investments in calculating expense factors reduces the level of those factors. This is attributable to the fact that current investment is used in the denominator of the factor calculation. The greater the denominator the lower the factor. Since this factor is used to develop operating costs, the lower the factor the lower the cost. However, in calculating the future cost of these same facilities in their model they find that the future costs of building these facilities is significantly less than the cost reflected on the ILEC's books. This reduced investment level is then used to calculate the capital and maintenance costs for building these facilities. The lower the investment the lower the overall cost of the services. They use the higher TPI estimated future costs in developing factors where it reduces the cost produced by the model. They then turn around and use the lower model projected future costs when those result in reducing the overall cost results. The only consistency in their approach is to always select the investment level which produces the lowest overall costs. They never worry about the inconsistencies or contradiction within their own model, as long as the result is lower costs. They do not even feel compelled to explain them in the Order.

Actual trended investment analysis indicates that the cost of placing cable facilities is increasing. The nationally accepted, even by the FCC, telephone plant indexes indicates that the cost of these facilities is increasing. The SM produces results that contradict all this empirical data based on the beliefs and assumptions of its sponsors. In fact the only time the FCC seems to acknowledge this information is when it can be employed to reduce the expense factors and therefore the overall cost of the model.

IV. CONCLUSIONS / RECOMMENDATIONS

Alternative Proposal to Sizing and Targeting High Cost

U S WEST has worked with the industry since 1993 to develop an accurate forward-looking model to identify high cost areas and determine the correct size of the universal service fund. The FCC's proposed model produces aberrant cost results, cannot be audited or documented, and is loaded with downward biases which, frankly, make it useless.

If the FCC is truly interested in providing support to high cost areas in the U.S., it should abandon its flawed approach and refocus on the goal of simply directing support to high cost areas. This can be accomplished if the FCC focuses on the primary reason service to an area is high cost. The reason is density. A simple three step process, can be used to target and size the fund. The FCC must first identify the areas across the nation that have low-population density. For example, the FCC could identify areas that have fewer than 200 persons per square mile. These areas can be identified using geographic information systems and commercially available data. The second step is to ask eligible telecommunications carriers (ETC) to provide geocoded service address data (latitude and longitude) for each customer they serve in these areas. If an ETC wishes to receive support, it must identify its customer locations in the low-density areas. If a company does not wish to receive support, it need not provide the customer location data. The final step is to use a simplified cost equation to develop the cost. The support level needs to be a reasonable estimate, not an exact engineering replica of the network cost. Ultimately, the fund size is a political decision. The time has come to abandon a process that will never work and move on to a practical method of actually solving the high cost universal service dilemma.

Respectfully submitted,

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July 23, 1999

ATTACHMENT A

AN ANALYSIS OF THE FCC'S REGRESSION-BASED INPUTS TO THE SYNTHESIS MODEL

I. Qualifications

My name is Gregory M. Attiyeh. I am a Senior Economist at LECG, Inc. My business address is 2000 Powell Street, Suite 600, Emeryville, CA 94608. I hold a Ph.D. in Economics from the University of Arizona, specializing in applied microeconomics, experimental economics, and econometrics. My industry experience prior to joining LECG includes consumer demand modeling for Bell Labs, AT&T, and econometric research as a consultant for the Graduate Record Examinations Board at the Educational Testing Service. At LECG, I have managed case work and preparation of economic expert testimony for various telecommunications proceedings, including competitive analyses and public interest assessments of Regional Bell filings for long distance entry; rate proceedings; and interconnection arbitration proceedings and cost dockets. I have also focused on financial modeling and valuation for telecommunications industry clients. This includes assessing the financial and competitive impacts of the Telecommunications Act of 1996 and the FCC's order to open local exchange markets to competition; regulatory delay of Bell entry into long distance; and telecommunications deregulation in Canada. I have performed or assisted with business valuations of entry into wireless (PCS), local exchange, and high capacity service markets.

My name is William L. Fitzsimmons. I am a Principal at LECG, Inc. My business address is 2000 Powell Street, Suite 600, Emeryville, CA 94608. I hold a Ph.D. in Resource Economics from the University of Massachusetts, Amherst. My industry experience prior to joining LECG in 1994 includes two years modeling demand for private line services for AT&T and six years building financial simulation models for BellSouth. At LECG, my work is focused on the analysis and financial modeling of a wide range of telecommunications issues. Beginning in 1996, I worked closely with U S WEST on the revisions of its cost models, and I testified on behalf of U S WEST in numerous interconnection arbitrations, consolidated cost dockets, and universal service proceedings. In these proceedings, I presented analyses of total element and total service long run incremental cost modeling issues. Earlier this year I worked extensively on the development of the LECG Entry Model. This model simulates the financial business cases for competitive local exchange carriers in mid-sized metropolitan areas. A copy of a paper describing the model and results was filed with the FCC on behalf of Ameritech.

The complete curriculum vitae of Drs. Attiyeh and Fitzsimmons are attached to this affidavit as Attachment I.

I. Introduction

The FCC proposes to use regression outputs in the formulation of cable and structure cost inputs and to attribute expenses in the Synthesis Model (SM). Their stated goal is to provide objective estimates, thereby decreasing the reliance on expert opinions and facts that are difficult to verify. Although this is a worthy goal, deficiencies of the data, questionable model specifications, extrapolations far beyond the scope of the data, and the introduction of significant outside information, lead us to conclude that the regressions do not achieve this goal.

II. Cable and Placement Cost Input Values

A. The Importance of Accurate Cable and Placement Cost Input Values

1. Comparisons of Model Inputs for Cable and Placement Costs

For many cost model inputs there are no sources for exact values. For these inputs, cost modelers strive to collect information and develop methods to estimate reasonable values. In this section we demonstrate that some of the input values estimated by the FCC's proposed regressions methodology are significantly different from the values used in other cost models, and that these differences significantly alter the output. Comparing input values from different models identifies areas of concern and establishes ranges for testing the importance of these inputs to the outputs of the model.

For two-plus years the reasonableness of the values for inputs used in cost models, such as the BCPM and HAI model, has been a focus of numerous regulatory proceedings. Comparing SM cable and structure cost input values with values from BCPM and HAI illustrates where the values proposed by the FCC fall in this debate. The fact that FCC input values differ, sometimes by large amounts, from values in other cost models does not indicate that the SM input values are incorrect. Large differences do, however, identify areas that deserve closer analysis.

Differences among **buried copper cable** cost input values from different models are relatively small. Differences among input values for **aerial fiber cable** and **placement** costs are relatively large.

Cable costs include the actual cable and the basic activities necessary to install the cable, such as delivering the cable to the site and laying it in the ground.[1] They do not include the more labor intensive placement activities such as digging trenches, and they do not include placement structures, such as poles and conduit. It is our understanding that U S WEST estimates cable costs for each state based on the actual prices that it pays for cable.[2] BCPM values for copper cable costs are generally lower than the FCC's proposed values for underground cable, similar for buried cable, and higher for aerial cable. Overall, differences between the BCPM and SM fiber cable costs are more pronounced than the differences in copper cable costs. Many of the FCC's proposed buried and aerial fiber costs are less than one-half of the costs actually paid by U S WEST.

[1] These cost are sometimes called EF&I (engineered, furnished and installed).

[2] It is not possible to display U S WEST's proposed cable cost inputs, because they are drawn from actual vendor prices, which are proprietary.

Placement costs are the cost of plowing, digging trenches, cutting and restoring road surfaces, boring under lawns, and installing conduit, poles, anchors and guys. In Table 1, the input values for buried placement under normal soil conditions proposed by the FCC are compared with the values from the HAI model and U S WEST's inputs for the BCPM model in Minnesota.[3] The FCC's proposed placement costs inputs are much lower than the values from either the HAI or BCPM models in the lowest density zone and slightly lower in the next density zone. For the middle five density zones, the FCC's proposed input values are similar to the HAI values but substantially lower than the values proposed by U S WEST for use in the BCPM. In the two highest density zones, the SM values are considerably lower than the HAI model and somewhat lower than U S WEST's values.

Table 1

Comparison of Buried Placement Costs

Normal Soil Conditions (\$/foot)

Density	SM	HAI	BCPM*
0	\$0.77	\$1.77	\$1.46
5	\$1.40	\$1.77	\$1.81
100	\$1.60	\$1.77	\$4.35
200	\$2.03	\$1.93	\$5.66
650	\$2.31	\$2.17	\$8.14
850	\$2.83	\$3.54	\$8.16
2550	\$3.97	\$4.27	\$8.70
5000	\$6.48	\$13.00	\$9.50
10000	\$10.13	\$45.00	\$10.46

* U S WEST inputs for Minnesota

2. Impacts of the Differences in Cable and Placement Costs

[3] U S WEST's proposed placement costs for Minnesota are shown as the weighted average costs for feeder and distribution placement.

Rerunning the SM with input values that are derived from BCPM and HAI provides a perspective on the importance of these inputs to the cost of providing service. Impacts of using the BCPM **cable costs** in the SM model are most pronounced in the lowest density zones, where the costs increase by 46 and 27 percent. Overall, the basic service cost estimated by the SM for Minnesota increases by $2.67 (13 percent) when U S WEST's values for BCPM are used in place of the cable cost proposed by the FCC. These differences are large enough to warrant additional analysis.

Table 2

SM Results for U S WEST Minnesota With SM and BCPM Cable Cost Inputs

	Basic Local Service			
Density (lines/sq mi)	SM Inputs	BCPM Inputs*	Difference	Percent Difference
0	$151.19	$220.74	$69.55	46%
5	$56.95	$72.51	$15.56	27%
100	$24.79	$27.51	$2.72	11%
200	$19.19	$20.73	$1.54	8%
650	$17.47	$18.62	$1.15	7%
850	$16.10	$16.96	$0.86	5%
2,550	$14.24	$14.79	$0.55	4%
5,000	$12.81	$13.14	$0.33	3%
10,000	$11.60	$11.81	$0.21	2%
Overall	$20.54	$23.21	$2.67	13%

* U S WEST inputs for Minnesota

Impacts of replacing the SM **placement cost** input values with those proposed by U S WEST for the BCPM are spread more evenly across the first seven density zones, and are most pronounced in density zones three through six. Overall, the basic local service cost estimated by the SM for Minnesota increases by $2.35 (11 percent) when U S WEST's values for buried placement are used in place of the placement costs proposed by the

FCC. When U S WEST's proposed values for aerial, buried, and underground are used, the SM cost for basic local service in Minnesota increases by $3.18 (15 percent). These differences are also large enough to warrant additional analysis.

Table 3

SM Results for U S WEST Minnesota With SM and BCPM Buried Placement Cost inputs

	Basic Local Service			
Density (lines/sq mi)	SM Inputs	BCPM Inputs*	Difference	Percent Difference
0	$151.19	$176.69	$25.50	17%
5	$56.95	$61.30	$4.35	8%
100	$24.79	$30.77	$5.98	24%
200	$19.19	$22.32	$3.13	16%
650	$17.47	$20.82	$3.35	19%
850	$16.10	$18.06	$1.96	12%
2,550	$14.24	$15.00	$0.76	5%
5,000	$12.81	$13.13	$0.32	2%
10,000	$11.60	$11.87	$0.27	2%
Overall	$20.54	$22.89	$2.35	11%

* U S WEST inputs for Minnesota

B. Analysis of Development of the SM Cable and Structure Input Values

1. National versus state-specific inputs

Geographic factors, such as transportation requirements, can affect the cost of structural materials, such as poles and concrete. Differences in labor rates and climate can also have a large impact on cable costs and the costs of activities used to place cable. Information gathered for BCPM by U S WEST indicates that there are meaningful differences between states in the costs of buried and underground plant structure.[4] For example, per-foot placement costs in Montana or Utah are 20 to 30 percent greater than in Minnesota for the mid to high density zones. (See Table 4.) To the extent that these differences are present, SM's use of uniform cable and structure cost inputs introduce inaccuracies.

Table 4

U S WEST's State Specific Values for Placement Costs ($/foot)

Density	UT	MN	MT
0	$1.34	$1.46	$1.32
5	$1.80	$1.81	$1.79
100	$5.14	$4.29	$5.11
200	$7.04	$5.63	$7.01
650	$10.36	$8.13	$10.33
850	$10.43	$8.17	$10.40
2550	$11.17	$8.70	$11.13
5000	$11.66	$9.50	$11.59
10000	$12.73	$10.43	$12.63

2. Large Ex-Post Cost Adjustments

The FCC makes large ex-post cost adjustments to the regression results. Based on external studies, the FCC makes: 1) downward adjustments for non-rural LEC bargaining power of 15-33 percent; and 2) upward adjustments for LEC engineering and splicing cost loadings of 9-10 percent. Between 25 and 40 percent of the information used to establish cable costs come from outside adjustments. These adjustments are derived from outside studies. To verify the reasonableness of these adjustments, it will be necessary to analyze these studies. Mixing and matching data in this fashion is precarious, because it

[4] It is our understanding that these inputs are based on actual contracts for placing cable in each state.

relies on the non-overlap of the costs included from different studies performed with different data for different purposes.

3. Placement Sharing

It is our understanding that there is very little sharing of placement costs in the rural areas represented by the Rural Utilities Service (RUS) data, but that any sharing that occurred is included in these data. To the extent that sharing is included in the RUS data, it is inappropriate to count the sharing again in the SM. Because the FCC proposes to extrapolate the results of its regressions to all density zones, this potential double counting of sharing extends to suburban and urban area cost estimates.

4. Regression methodology

Key motivations for basing the cost estimates on the RUS data set were 1) the use of publicly available data would enable regulatory agencies and other interested parties to validate the results,[5] and 2) the estimation does not require "engineers making too many judgments, which are difficult, if not impossible, to audit."[6] Although the RUS data undoubtedly adds useful information to the mix, it does not appear that the FCC's regression analysis preserved either of these two potential advantages.

First, although publicly available, the RUS data set contains insufficient information for developing the SM cost inputs. Consequently, it was necessary for the FCC to make significant adjustments based on information that is outside of the data used in the regressions analysis. These adjustments are based on outside studies and inputs and results from the BCPM and HAI cost models, some of which stem from proprietary information. Validation of the SM model, therefore, entails the validation of proprietary information and the BCPM and HAI models in addition to the RUS data set.

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[5] David Gabel & Scott Kennedy, *Estimating the Cost of Switching and Cables Based on Publicly Available Data*, (The National Regulatory Research Institute, April 1998), p. 1. (Hereafter, NRRI Study).
[6] NRRI Study, p. 9.

Second, the use of regression analysis to develop cost inputs entails judgment regarding model specification, estimation methodology, forecasts, and treatment of the data. The FCC, however, has not shown sufficient consideration in any of these regards. Examples include altering model specifications proposed by Gabel and Kennedy without explanation, implementing ad hoc and potentially inconsistent adjustments (such as bargaining power adjustments), and the questionable use of extrapolations to extend forecasts well outside the range of the sample.

a) Model Specifications

Prior to running regressions it is necessary to specify the theoretical model that is expected to reflect the causal relationships of interest. Data are then used to estimate the magnitude of the relationships and determine if the results are significant. The FCC based its regression analysis on the analysis of Dr. Gabel and Mr. Kennedy, with several noticeable modifications.[7] It is not entirely clear why the FCC modified the models as described in Appendix D of its Notice, and it is not clear why the specifications differ for different types of cable costs. Why, for example, does the cable cost equation for underground cable cost include a squared term on cable size, when this term is not in the equations for aerial or buried cable? There were no squared terms in the original models specified by Kennedy and Gabel. Including variables for "line size" and "line size squared" indicates that the FCC hypothesized a non-linear relationship between line size and cable cost. It is not unreasonable to expect that the cost tapers with increasing cable size, but it is curious that the FCC only expected to find this relationship for underground cable, and it is troubling that this model specification produces negative marginal costs for cable sizes greater than 1800 pairs and negative total cable cost estimates for cable sizes larger than 3600 pairs. Even more troubling is the fact that the FCC's proposed inputs do not match the output from the regression.[8] Table 5 compares the FCC's

[7] NRRI Study.

[8] If cost relationship is truly nonlinear, a log-linear specification may be more tractable because the function does not peak, thereby avoiding negative predicted costs for large cable sizes. The nonlinearity would complicate the application of "bargaining power" adjustments, however. If a log-linear specification

proposed input values for underground copper cable with the values that are calculated from the regression described in their Notice. [9]

Table 5

Comparison of the FCC's
24 Gauge Underground Copper Cable Cost Input Values
and the Results of the FCC Regression ($/foot)

# of Pairs	FCC Values	Values Derived from Regression	Difference
4200	$39.32	($15.28)	($54.60)
3600	$33.70	($2.49)	($36.19)
3000	$28.09	$6.87	($21.22)
2400	$22.47	$12.79	($9.68)
2100	$19.66	$14.46	($5.20)
1800	$19.10	$15.27	($3.83)
1200	$16.02	$14.30	($1.72)
900	$13.51	$12.54	($0.97)
600	$10.35	$9.91	($0.44)
400	$7.88	$7.68	($0.20)
300	$6.53	$6.42	($0.11)
200	$5.11	$5.06	($0.05)
100	$3.63	$3.61	($0.02)
50	$2.86	$2.85	($0.01)
25	$2.46	$2.46	$0.00
18	$2.35	$2.35	$0.00
12	$2.26	$2.26	$0.00
6	$2.16	$2.16	$0.00
1	$2.06	$2.08	$0.02

is desirable, bargaining power adjustments would have to be netted out of the material costs, prior to regression, as recommended to by Gabel and Kennedy. See NRRI Study, p. 50.

b) Excluding Variables

The FCC equation for aerial cable includes a dummy variable for instances when multiple cables are placed at the same location. Because the coefficient on this equation is insignificant, the FCC does not use the variable when it estimates the cable costs. It does not even rerun the equation with the variable omitted; it simply ignores the impact of the variable. This is inappropriate. If a variable is in the estimating equation, then eliminating it from the application of the equation biases the result. When a variable is used to estimate an equation then it belongs in the equation. It is not appropriate to "mine the data" to find the best fit. If, however, the decision is made to remove a variable, at the very least the model should be rerun without the variable prior to using the estimated equation to set input values. Furthermore, as with the decision to include a quadratic term, some theoretical consideration to consistency across models for different cable types should be made in deciding whether to include variables, such as dummy variables for placing multiple cables, in the equation.

c) Robust Regressions

The FCC bases its regression analysis on the analysis of Dr. Gabel and Mr. Kennedy, with several noticeable modifications. One modification is that the FCC adopts what is known as the "robust" regression technique. Robust regressions are a means of excluding or discounting information contained in "outlier" observations. If there are legitimate reasons for instances where cable costs are unusually high or low, eliminating these observations from the analysis will bias the results. There may be legitimate reasons for using the robust regression technique, but these reasons are not discussed in the FCC's Notice, except to say that outliers were present. A more careful consideration of the facts leads us to the conclusion that, unless the FCC can support the elimination of information, the ordinary least squares regression technique used in the original Gabel/Kennedy analysis will provide more reasonable and supportable results.

[9] Further Notice of Proposed Rulemaking, In the Matter of Federal-State Board on Universal Service and Forward-Looking Mechanism for High Cost Support for Non-Rural LECs. CC Docket No. 96-45 & 97-160, FCC No. 99-120. Adopted May 27, 1999. Cite FCC NPRM. Pp. D-2 to D-3. (Hereafter, NPRM).

Gabel and Kennedy also removed outliers from their data, and this is the data used in the FCC's regressions. The rationale for removing these data was that "[I]f the data from these two projects had not been excluded, the regression estimates would not have made much sense."[10] Without addressing the merits of this type of data reduction, what is clear is that Gabel/Kennedy eliminated observations from specific contracts because they suspected that the costs were too high. With the application of the so called robust regression technique, the FCC eliminates over 50 observations in one regression that we investigated and gives lower weights to a large number of other observations. We have several concerns with this method of eliminating information. First, the data provided by Gabel/Kennedy already was reduced as described above. Second, all but one of the observations deleted by the FCC and the contracts deleted by Gabel/Kennedy were observations where the costs were higher than average. Finally, the blind application of the FCC's regression technique does not even consider the possible reasons why certain projects have costs that are well above average. In his book, A Guide to Econometrics, Peter Kennedy explains,

> Once influential observations have been identified it is tempting just to throw them away. This would be a major mistake. Often influential observations are the most valuable observations in a data set.... Furthermore, outliers may be reflecting some unusual fact that could lead to an improvement in the model's specification.
>
> The first thing that should be done after influential observations have been identified is to examine these observations very carefully to see if there is some obvious reason why they are outliers.[11]

To assess the impact of the FCC's use of robust regression, we reran the FCC's buried placement cost regression with ordinary least squares (OLS). The results are provided in Table 6 and compared with the input values in the HAI model and proposed by U S WEST for use in the BCPM.

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[10] NRRI Study, p. 39.
[11] Kennedy, Peter, *A Guide to Econometrics*. The MIT Press. Cambridge, Massachusetts. 1992. P. 280.

Table 6

Buried Cable Placement Costs

Robust and OLS Regression Results versus

Values from HAI and U S WEST ($/foot)

Density	Robust	OLS	HAI	U S WEST*
1	$0.77	$1.39	$1.77	$1.46
2	$1.40	$1.93	$1.77	$1.81

* U S WEST inputs for Minnesota

As shown in Table 6, the FCC's choice of robust regression analysis has a large impact on the estimated costs of buried placement. Ordinary least squares regression, which is the most commonly used and widely accepted regression technique, provides cost estimates that are much more in line with the values in the HAI model and the BCPM. Given the dramatic impact of replacing the OLS methodology with robust regression, adequate analysis and justification by the FCC for adopting this less often used regression technique is glaring by its absence.

Robust regressions also have a significant downward impact on the FCC's proposed cable cost input values. Table 7 presents the results of the FCC's equations with ordinary least squares (OLS) regression and robust regressions.

Table 7

Comparison of OLS and Robust Regression Based Input Values for 24 Gauge Buried Copper Cable ($/foot)

# of Pairs	SM Input: Robust Regression	OLS Regression	Difference
4200	$46.25	$51.43	$5.18
3600	$39.78	$44.22	$4.44
3000	$33.31	$37.01	$3.70
2400	$26.84	$29.80	$2.96
2100	$23.60	$26.19	$2.59
1800	$20.37	$22.59	$2.22
1200	$13.90	$15.38	$1.48
900	$10.66	$11.77	$1.11
600	$7.43	$8.17	$0.74
400	$5.27	$5.76	$0.49
300	$4.19	$4.56	$0.37
200	$3.11	$3.36	$0.25
100	$2.03	$2.16	$0.13
50	$1.49	$1.56	$0.07
25	$1.22	$1.26	$0.04
18	$1.15	$1.17	$0.02
12	$1.08	$1.10	$0.02

d) Data Issues

The data used by the FCC to estimate the costs of buried placement contains only 26 observations in density zone one. This small sample size contributes to a low level of statistical confidence for the precision of its buried cost estimate in this density zone. In other words, the cost estimate has a wide confidence interval. Table 8 shows the 95 percent confidence intervals for estimates of buried costs for density zone one using robust and OLS regression. Using OLS regression, the point estimate is $1.39 per foot. But given the nature of the data, we are 95 percent confident that the actual cost of placing buried cable is between $0.18 and $2.60 per foot. By reducing the variability in the underlying data, the robust regression technique has a narrower, but still wide, confidence interval. Note also that in the confidence intervals listed below we assume that the ex-post adjustments made by the FCC (LEC engineering costs and the adjustment to the intercept) are known with certainty. To the extent that there is uncertainty about the exact values of these adjustments, the ranges of these confidence intervals are conservative (small).

Table 8

Density Zone 1 Buried Cable Placement Costs

And Confidence Intervals ($/foot)

Technique	Cost Estimate ($/ft)	Confidence Intervals Lower 95%	Upper 95%
OLS	$1.39	$0.18	$2.60
Robust	$0.77	$0.12	$1.42

The impact of using the FCC's proposed buried placement costs is large. Given the small amount of data and the paucity of support for adopting robust regression, there is no valid reason to depart so dramatically from the buried placement cost values used in other cost models for density zone one. The same conclusion holds true for density zone two, which is used as the "jump-off" point for the FCC's misguided extrapolation of values for the remaining density zones. This is the subject of the following section.

C. Regression results for placement costs are used to estimate cost relationships that are far outside of the range of the underlying data

Regression analysis is a method of "fitting" a prespecified equation to a set of data. The coefficient on each explanatory variable is an estimate of the causal relationship between the explanatory variable and the dependent variable. For example, the estimated coefficient for the variable "number of cable pairs" is the estimated increase in cost for an additional cable pair. If the equation is properly specified and the statistical properties of the estimated coefficient indicate that the relationship is significant, it is reasonable to assume that the relationship will apply under similar conditions. Even for a properly specified equation with coefficients that are deemed significant, however, it is not appropriate to assume that the relationships hold under very dissimilar conditions without further analysis. The following comments by Dr. Gabel and Mr. Kennedy reiterate this point.

> As a matter of sound economics, however, caution must be used to forecast costs for areas that are too dissimilar to those from which the data was obtained.[12]

FCC cable and placement cost regressions are based on data from the RUS.[13] As the name indicates, these data reflect rural conditions and are inadequate to provide meaningful information about placement costs in denser areas. First, the placement activities used most widely in rural areas are not representative of the activities that are used to place cables in areas with higher population densities. In rural areas, even in a "scorched node" world, most buried cable would be plowed into the ground.[14] This is much less expensive than other techniques, such as boring and cutting and restoring asphalt and concrete, that are required to place a new network in less rural areas, where it is necessary to account for the presence of houses, driveways, gardens and other obstructions. The FCC recognized that the RUS data only provides estimates that reflect conditions in the lowest two density zones in its model.

[12] NRRI Study, p. 37.

[13] RUS data are from rural companies. "Rural areas means any area of the United States, its territories and insular possessions (including any area within the Federated States of Micronesia, the Republic of the Marshall Islands, and the Republic of Palau) not included within the boundaries of any incorporated or unincorporated city, village or borough having a population exceeding 5,000 inhabitants." See http://www.usda.gov/rus/telephone/regs/1735.htm.

[14] Recall that the FCC model is designed to estimate costs in a total service long run incremental cost (TSLRIC) environment. A TSLRIC world includes the current locations of the network nodes and all houses, driveways, buildings, gardens and streets, but no telephone plant.

To use its regression results for non-rural areas, the FCC proposes to extrapolate the results of its equations for density zone 2 to density zones 3-9. The FCC "further tentatively conclude[s] that we should perform this extrapolation based on the growth rate in the BCPM and HAI default values for underground and buried structure."[15] There are several conceptual and mechanical flaws with this methodology. This approach is counter to the intent of the FCC to substitute "impartial" data for the judgement of engineers, and it is sure to produce flawed results. Extrapolation from costs based rural placement activities is inferior to using cost information that is based on the placement activities used in more dense areas.

We will use the buried placement cost values proposed by the FCC (presented above in Table 1) to demonstrate some of the flaws in the FCC's proposed methodology. The FCC uses the RUS data to estimate placement costs directly for the first two density zones. It is instructional to examine the change in the cost from density zone one to density zone two relative to the change that would be predicted with the FCC's own methodology. In the lowest density zone, the FCC proposes a cost of $0.77 per foot for placing buried cable. The FCC proposes a cost per foot of $1.40 in the second density zone, an increase of over 80 percent from the previous density zone. Using the FCC's own methodology of deriving the growth in costs across density zones from the blended growth rates in the HAI and BCPM models, the growth rate from density zone 1 to density zone 2 would be approximately 8 percent, and the placement cost per foot in density zone 2 would be $0.83. This comparison is summarized in Table 9. When the FCC's methodology fails to come close to matching the change in placement costs from density zone 1 to density zone 2, it is difficult to have any confidence in the applicability or expected accuracy of the methodology for predicting placement costs in density zones 3 through 9. This alone is reason enough to reject FCC's extrapolation methodology.

[15] NPRM at ¶ 45, p. D-17.

Table 9

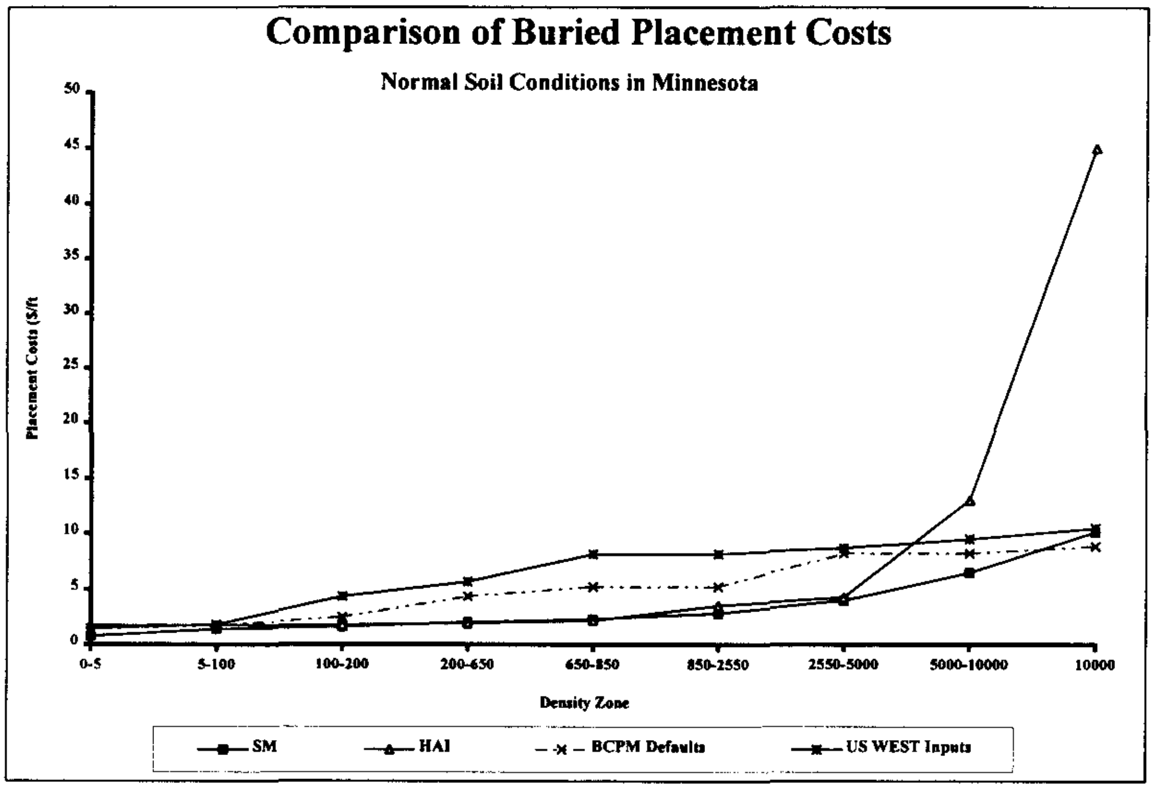
Comparison of SM Buried Placement Cost Inputs with Extrapolated Inputs

Density	SM Inputs	Use of FCC's Extrapolation Method
0	$0.77	$0.77
5	$1.40	$0.83
Percent Increase	82%	8%

Second, using flawed data to extrapolate placement costs in density zones three through nine is almost certain to produce flawed results. There are large differences between the BCPM default values and the values in the HAI model. By definition, at least one of the sets of inputs is seriously flawed. Furthermore, the FCC's proposed extrapolation methodology begins with default values for the BCPM that even the proponents of this model do not support. As noted by the FCC, "the BCPM sponsors have argued that we should use company-specific inputs and have proposed alternative values for company-specific structure costs in some study areas."[16] It seems pointless to base input values on information that is known to be incorrect.

The mechanics of the FCC's proposed extrapolation are also a concern. Although this method is based on the data from placement costs in HAI and BCPM, as seen in Figure 1, the resulting buried placement costs for density zones 3-7 are almost identical with the values in the HAI model. They are well below the BCPM default values and even further below the values proposed by U S WEST for Minnesota. This result is a function of the convoluted methodology proposed by the FCC, which uses averages of logarithmic growth rates and includes a straight average of growth rates from buried and underground placement. It is not clear why the FCC averages the growth rates from underground and buried placement, rather than use separate growth rates for these placement types. If an average is used, it would be more accurate to weight the growth rates by the amounts of buried and underground mileage.

Figure 1



Without better data, the FCC's proposal for patching together information and analysis to estimate cable and structure costs does not hold together. It provides a mismatch of information, especially for non-rural areas. A final point is that the FCC's flawed methodology does not lend itself to the process of improving inputs with further analysis and debate. For two-plus years, evidence was presented and the issues related to structure costs were debated in numerous state arbitration, cost, and universal service proceedings. These are hard issues that need to be taken head-on. It is not adequate to

[16] NPRM at ¶ 105, p. 43.

sidestep the issues with mismatched and flawed information. What is needed is a methodology that is based on the costs and frequency of occurrence of different placement activities and a careful collection and examination of the facts.

III. Regressions-Based Expense Input Values

A. Overview

The FCC proposes to use two regression equations as the basis for identifying portions of five expense accounts that should be attributed to services that are supported by universal service. The FCC proposes averaging the results of the two equations and applying several after model adjustments to reach a final determination for each expense account. Although rigorous statistical analysis has the potential of providing important insights into the cost causative relationships between services and expenses, and although the FCC's proposed methods and results are an important first step in this analysis, the process proposed by the FCC requires considerable additional work. As the proposal stands, it is impossible to have any confidence that the results are accurate or reasonable.

The regression-based cost allocation method proposed by the FCC does not provide a reasonable method for allocating expenses to basic local service. There are model specification and statistical problems with the FCC's method. One of the concerns with the FCC's proposed regression analysis is the fact that the underlying data for the explanatory variables are highly correlated. This creates a problem called multicollinearity. The statistical consequences of this condition, and the FCC's own standard for assessing the explanatory power of correlated variables, indicates that their equations do not serve the intended purpose.

We have concerns with: 1) the specifications of the regressions proposed by the FCC; 2) the use of highly correlated explanatory variables; and 3) the use of numerous adjustments to the regression results. We also have been unable to replicate the FCC's results for two of the five accounts (accounts 6510 and 6630). From our discussion, it appears the staff members at the FCC are also unable to replicate their results for these two accounts.

B. Model specification concerns

The first step in regression analysis is to specify an equation in which the *dependent variable* is caused by one or more *explanatory variables*. To the extent that causative relationships are not clearly established, the regression coefficients are not meaningful for developing inputs for a cost model. The FCC's proposed equations begin with the decision that the key drivers of expense categories are the demands for switched local, non-switched special, and toll services.

It is not at all clear that FCC's regressions are based on appropriate cost-causative relationships. Variations in the switched lines, special "lines" and toll minutes do not fully or appropriately reflect the cost causative relationships between expenses and services supported by universal service. This is one reason for the numerous after model adjustments. To illustrate the problems with the FCC's proposed regression equations, consider the issue of how to count special access lines – as access line equivalents, physical pairs, or some other measure? With electronic equipment, software, and two pairs of copper wires, it is possible to provide a unit of DS1 service that has a capacity to deliver twenty-four narrowband phone lines. The relevant question is, "How does special access service cause expenses?" The FCC counts each DS1 as 24 "lines' and each DS3 as 672 "lines." It is far from clear that this reflects how these services cause expenses. It is clear that DS1s and DS3s are not priced as if they cause 24 and 672 times the amount of expenses as a narrowband line. This specification issue requires additional analysis.

The FCC creates another problem in its proposed equations for attributing expenses when it removes the Local DEM variable from its model. Eliminating an explanatory variable that is deemed important because of correlation with another explanatory variable creates a mongrel model with unknown properties. If a variable is deemed important on theoretical grounds, eliminating the variable leaves a sample specific model that does not